CLAIMS

1   **1.**   An optical coherence tomography (OCT) system comprising:

2   an interferometer having a reference arm and a sample arm each having an optical path, the

3   sample arm being disposed such that a test sample reflects a sample portion R_S of an incident optical

4   signal S_S along the sample arm optical path;

5   a reflector disposed in the reference arm to reflect a reference portion R_R of an incident optical

6   signal S_R along the reference arm optical path;

7   a source for producing an optical source signal S having a short coherence length and a first

8   polarization state;

9   a polarizing beam splitter disposed to direct portions of the optical source signal S along the

10   reference arm optical path and the sample arm optical path;

11   a first polarizing element disposed to select, from the returning reference and sample portions

12   (R_R+R_S), a detector component S_D having a second polarization state; and

13   a detector disposed to produce an output signal V_D representing the optical signal intensity

14   I_D of the detector component S_D, wherein the second polarization state is related to the first

15   polarization state such that the detector operates in a noise-optimized regime.

1   2.   The OCT system of claim 1 further comprising:

2   a first filter coupled to the detector for separating, from the output signal V_D, a low-frequency

3   component V_L representing a scanning laser ophthalmoscope-like (SLO-like) image pixel;

4   first data storage means for storing a plurality of pixels $\{V_H\}$ representing a two-dimensional

5   (2D) OCT *en face* image;

6   second data storage means for storing a plurality of pixels $\{V_L\}$ representing a 2D SLO-like

7   image; and

8   processing means for removing motion artifacts from 2D OCT *en face* image data in

9   accordance with the corresponding SLO-like image data.

1   3.   The OCT system of claim 2 further comprising:

2   a scanner disposed to sweep the incident optical signal S_S over at least part of the test sample;

3 and

4   a reflector motor disposed to move the reflector along the reference arm optical path.

1   4.   The OCT system of claim 2 wherein the interferometer is a Michelson interferometer.

1   5.   The OCT system of claim 2 further comprising:

2   a second polarizing element disposed in the sample arm optical path such that the returning

3 sample portion R_S is directed by the polarizing beam splitter to the detector

1   6.   The OCT system of claim 2 further comprising:

2   in the processing means, rendering means for realigning the pixel data representing a 2D OCT

3 *en face* image with respect to the pixel data representing another 2D OCT *en face* image.

1   7.   The OCT system of claim 2 further comprising:

2   an attenuating element disposed in the reference arm optical path to attenuate optical signals

3 therein.

1   8.   The OCT system of claim 2 further comprising:

2   a second filter coupled to the detector for separating, from the output signal V_D, a high-

3 frequency component V_H representing an OCT image pixel.

1   9.   The OCT system of claim 1 further comprising:

2   a scanner disposed to sweep the incident optical signal S_S over at least part of the test sample;

3 and

4   a reflector motor disposed to move the reflector along the reference arm optical path.

1   10.   The OCT system of claim 1 wherein the interferometer is a Michelson interferometer.

1   11.   The OCT system of claim 1 wherein the interferometer is a Mach-Zehnder interferometer.

1   12.   The OCT system of claim 1 further comprising:

2   a second polarizing element disposed in the sample arm optical path such that the returning

3   sample portion R_S is directed by the polarizing beam splitter to the detector

1   13.   The OCT system of claim 1 further comprising:

2   a second polarizing element disposed in the reference arm optical path such that the returning

3   reference portion R_R is directed by the polarizing beam splitter to the detector.

1   14.   The OCT system of claim 1 further comprising:

2   in the detector, a plurality of optical transducers each disposed to produce an electrical signal

3   responsive to the detector component S_D.

1   15.   The OCT system of claim 1 wherein the second polarization state is related to the first

2   polarization state such that the detector operates in a shot-noise limited regime.

1   **16.**   An optical coherence tomography (OCT) system comprising:

2   an interferometer having a reference arm and a sample arm each having an optical path, the

3   sample arm being disposed such that a test sample reflects a sample portion R_S of an incident optical

4   signal S_S along the sample arm optical path;

5   a reflector disposed in the reference arm to reflect a reference portion R_R of an incident optical

6   signal S_R along the reference arm optical path;

7   an optical source for producing an optical source signal S having a short coherence length;

8   a beam splitter disposed in the interferometer to direct portions of the optical source signal

9   S along the reference arm optical path and the sample arm optical path;

10   a detector disposed to produce an output signal V_D representing the optical signal intensity

11   I_D of the returning reference and sample portions (R_R+R_S);

12   a first filter coupled to the detector for separating, from the output signal V_D, a low-frequency

13   component V_L representing a scanning laser ophthalmoscope-like (SLO-like) image pixel;

14   first data storage means for storing a plurality of pixels $\{V_H\}$ representing a two-dimensional

15   (2D) OCT *en face* image;

16   second data storage means for storing a plurality of pixels $\{V_L\}$ representing a 2D SLO-like

17 image; and

18   processing means for removing motion artifacts from 2D OCT *en face* image data in

19 accordance with the corresponding SLO-like image data.

1 17.   The OCT system of claim 16 further comprising:

2   a scanner disposed to sweep the incident optical signal S_S over at least part of the test sample;

3 and

4   a reflector motor disposed to move the reflector along the reference arm optical path.

1 18.   The OCT system of claim 16 further comprising:

2   an attenuating element disposed in the reference arm optical path to attenuate optical signals

3 therein.

1 19.   The OCT system of claim 16 further comprising:

2   a second filter coupled to the detector for separating, from the output signal V_D, a high-

3 frequency component V_H representing an OCT image pixel.

1 20.   The OCT system of claim 16 further comprising:

2   in the processing means, rendering means for realigning the pixel data representing a 2D OCT

3 *en face* image with respect to the pixel data representing another 2D OCT *en face* image.

1 **21.**   In an optical coherence tomography (OCT) system including a detector having a plurality of

2 noise-limited operating regimes and an interferometer having a reference arm and a sample arm each

3 having an optical path, the sample arm being disposed such that a test sample reflects a sample

4 portion R_S of an incident optical signal S_S along the sample arm optical path, a machine-implemented

5 method for rendering a three-dimensional (3D) image of a test sample comprising the unordered steps

6 of:

7   (a)   producing an optical source signal S having a short coherence length and a first

8 polarization state;

9   (b)   directing a first portion S_R of the optical source signal S along a reference arm optical
10   path and directing a second portion S_S of the optical source signal S along a sample arm optical path;

11   (c)   reflecting a reference portion R_R of the first portion S_R along the reference arm optical
12   path;

13   (d)   selecting, from the returning reference and sample portions (R_R+R_S), a detector
14   component S_D having a second polarization state; and

15   (e)   producing an output signal V_D representing the optical signal intensity I_D of the
16   detector component S_D, wherein the second polarization state is related to the first polarization state
17   such that the detector operates in a noise-optimized regime.

1   22.   The method of claim 21 further comprising the steps of:

2   (f)   separating, from the output signal V_D, a low-frequency component V_L representing a
3   scanning laser ophthalmoscope-like (SLO-like) image pixel and a high-frequency component V_H
4   representing an OCT image pixel;

5   (g)   storing at least one value V_H representing a two-dimensional (2D) OCT *en face* image
6   pixel;

7   (h)   removing a motion artifact from 2D OCT *en face* image data in accordance with the
8   corresponding SLO-like image data.

1   23.   The method of claim 22 further comprising the step of:

2   (g.1)   storing at least one detector output component V_L representing a 2D SLO-like image
3   pixel.

1   24.   The method of claim 22 further comprising the step of:

2   (h.1)   realigning the pixel data representing a 2D OCT *en face* image with respect to the
3   pixel data representing another 2D OCT *en face* image.

1   25.   The method of claim 21 further comprising the steps of:

2   (b.1)   sweeping the second portion S_S over at least part of the test sample; and

3   (c.1)   moving the reflector along the reference arm optical path.

1   **26.**   In an optical coherence tomography (OCT) system including a detector having a plurality of

2   noise-limited operating regimes and an interferometer having a reference arm and a sample arm each

3   having an optical path, the sample arm being disposed such that a test sample reflects a sample

4   portion R_S of an incident optical signal S_S along the sample arm optical path, a machine-implemented

5   method for rendering a three-dimensional (3D) image of a test sample comprising the unordered steps

6   of:

7   (a)   producing an optical source signal S having a short coherence length;

8   (b)   directing a first portion S_R of the optical source signal S along a reference arm optical

9   path and directing a second portion S_S of the optical source signal S along a sample arm optical path;

10   (c)   reflecting a reference portion R_R of the first portion S_R along the reference arm optical

11   path;

12   (d)   selecting, from the returning reference and sample portions (R_R+R_S), a detector

13   component S_D;

14   (e)   producing an output signal V_D representing the optical signal intensity I_D of the

15   detector component S_D;

16   (f)   separating, from the output signal V_D, a low-frequency component V_L representing a

17   scanning laser ophthalmoscope-like (SLO-like) image pixel and a high-frequency component V_H

18   representing an OCT image pixel;

19   (g)   storing at least one value V_H representing a two-dimensional (2D) OCT *en face* image

20   pixel; and

21   (h)   removing a motion artifact from 2D OCT *en face* image data in accordance with the

22   corresponding SLO-like image data.

1   27.   The method of claim 26 further comprising the step of:

2   (g.1)   storing at least one detector output component V_L representing a 2D SLO-like image

3   pixel.

1   28.   The method of claim 26 further comprising the step of:

2   (h.1)   realigning the pixel data representing a 2D OCT *en face* image with respect to the

3   pixel data representing another 2D OCT *en face* image.

1   29.   The method of claim 26 further comprising the steps of:

2   (b.1)   sweeping the second portion S_S over at least part of the test sample; and

3   (c.1)   moving the reflector along the reference arm optical path.

1   **30.**   A computer program product for use in an optical coherence tomography (OCT) system

2   including an interferometer having a reference arm and a sample arm each having an optical path, the

3   sample arm being disposed such that a test sample reflects a sample portion R_S of an incident optical

4   signal S_S along the sample arm optical path, a reflector disposed in the reference arm to reflect a

5   reference portion R_R of an incident optical signal S_R along the reference arm optical path, an optical

6   source for producing an optical source signal S having a short coherence length, a beam splitter

7   disposed in the interferometer to direct the optical source signal S along the reference arm optical

8   path and the sample arm optical path, a detector disposed to produce an output signal V_D representing

9   the optical signal intensity I_D of the optical signals returning from the reference mirror and the test

10   sample and a filter coupled to the detector for separating, from the output signal V_D, a low-frequency

11   component V_L representing a scanning laser ophthalmoscope-like (SLO-like) image pixel, the

12   computer program product comprising:

13   a recording medium;

14   means recorded on the recording medium for directing the OCT system to store at least one

15   value V_H representing a two-dimensional (2D) OCT *en face* image pixel and store at least one value

16   V_L representing a 2D SLO-like image pixel; and

17   means recorded on the recording medium for directing the OCT system to remove a motion

18   artifact from 2D OCT *en face* image data in accordance with the corresponding SLO-like image data.